Early Evolution of the Mission Architecture for NASA's Europa Lander Concept

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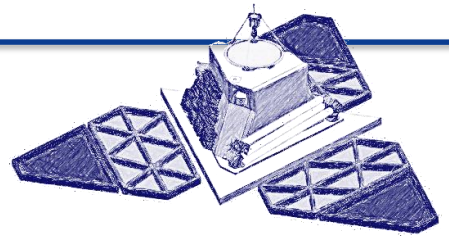
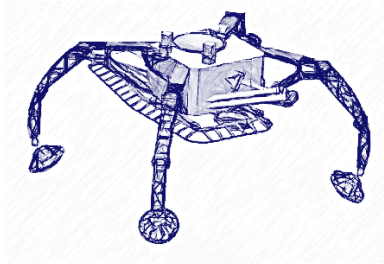
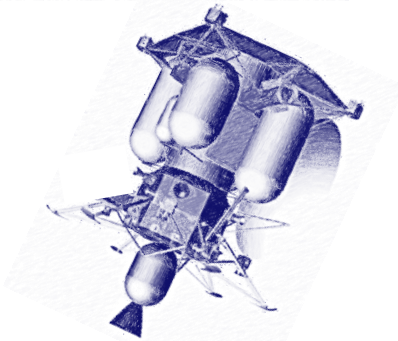
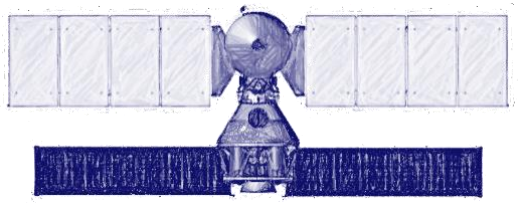
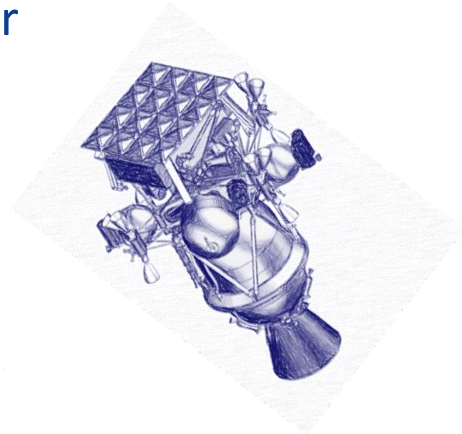
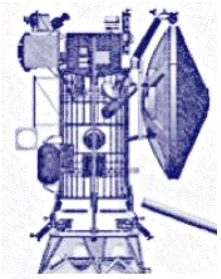
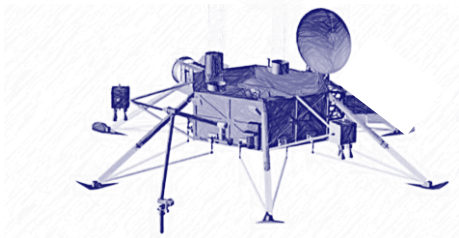
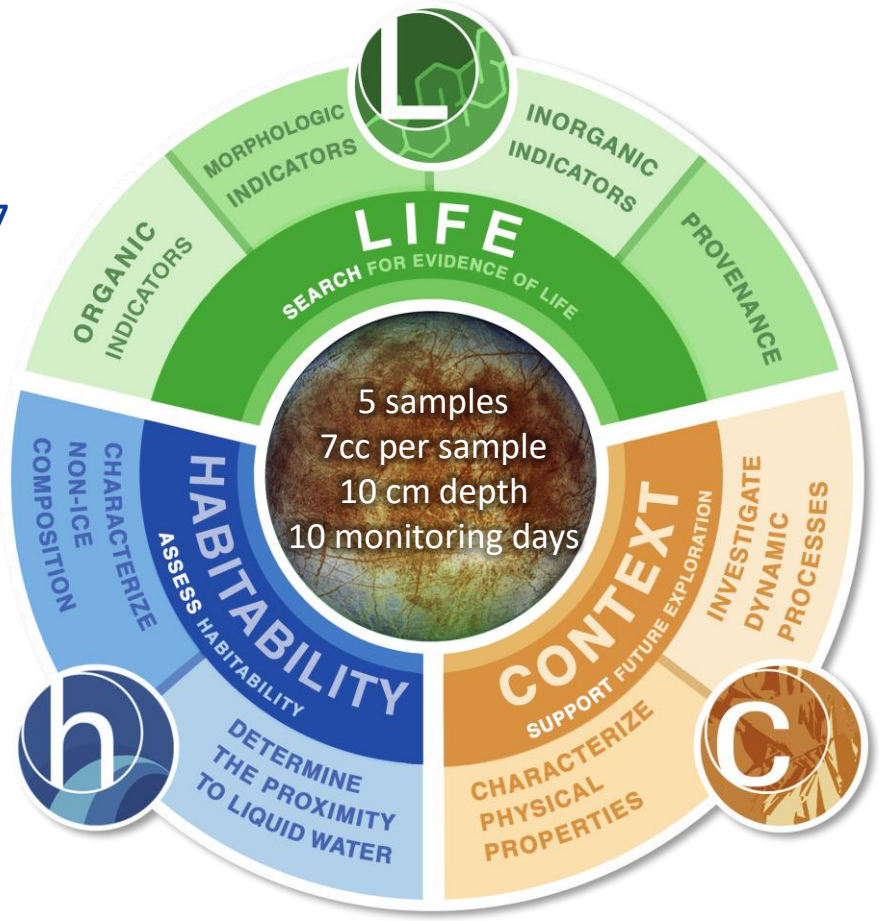
Background

- Europa lander concepts have been studied at JPL since Galileo mission
- NASA's planned Europa Clipper mission would provide opportunity for additional reconnaissance, significantly reducing the risk for a potential lander mission
- NASA directed JPL to proceed with a pre-project study in June 2016
- Currently in concept /early formulation phase, KDP-A possibly later this year

A Robust Approach to Searching for Signs of Life

- Science Definition Team (SDT) convened by NASA, June 2016
- SDT findings & recommendations submitted to NASA, February 2017



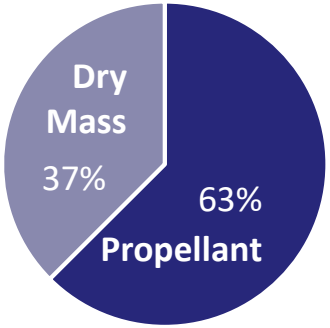
Four Significant Driving Challenges

What makes the Europa Lander concept more challenging than Mars or Lunar landers?

1 – Required Mass

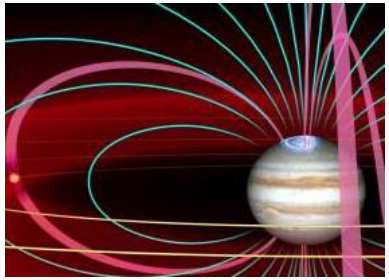
- 42.5 kg payload
- 500 kg lander
- 16 ton launch stack

- Requires SLS Block 1b capability

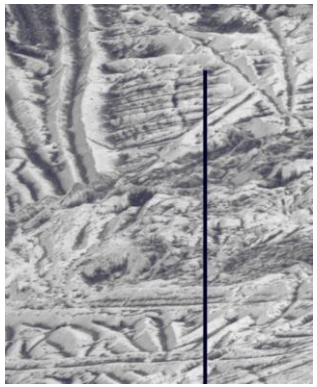


3 – Jovian Radiation Environment

- Strong irradiation from particles trapped in Jupiter's magnetosphere
- Degradation of materials, interruptions
- Shielding & vault design
- Limiting factor for surface mission duration



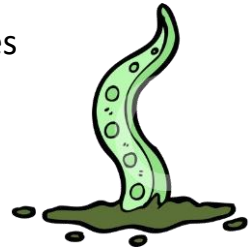
2 – Surface Topography & Properties



- Best Galileo imagery at ~6 m/pixel shows rough topography, unknown on lander scale
- Higher resolution recon from Clipper, after lander launch
- Concept: soft landing, pin-point landing, hazard detection & avoidance, adaptive landing system

4 – Planetary Protection

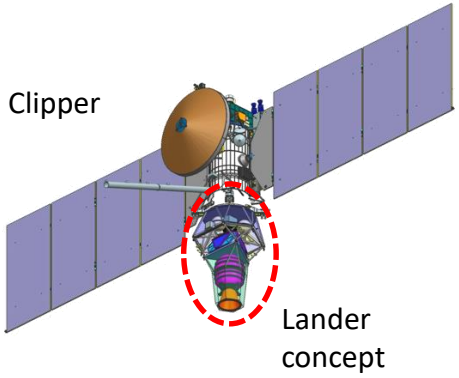
- Europa is prime candidates for hosting life
- Probability of $<10^{-4}$ of contamination with a viable organism
- Cleaning and sterilization techniques required are drivers for Assembly, Test, and Launch Operations (ATLO)



Three Lander Architecture Concepts

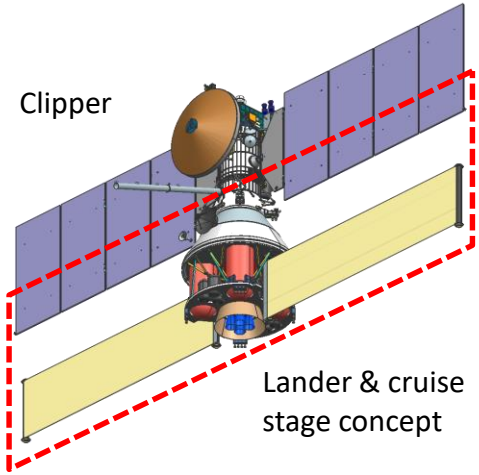
"Piggy Back"

- Lander & Clipper co-manifested
- Separation shortly before landing
- Clipper…
  - carries lander through Clipper mission,
  - stays in Jupiter orbit,
  - delivers lander to Europa,
  - relays lander science data to Earth after landing



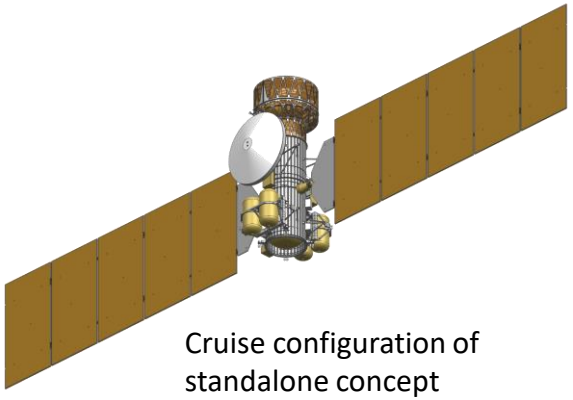
"Free Flyer"

- Lander & Clipper co-manifested
- Separation after Jupiter orbit insertion
- Cruise stage delivers lander to Europa after end of Clipper mission
- Clipper
  - stays in Jupiter orbit,
  - relays lander science data to Earth after landing



"Standalone"

- Dedicated launch for lander, years after Clipper launch
- Carrier stage
  - captures into Europa space,
  - delivers lander to Europa after end of Clipper mission,
  - relays lander science data to Earth after landing

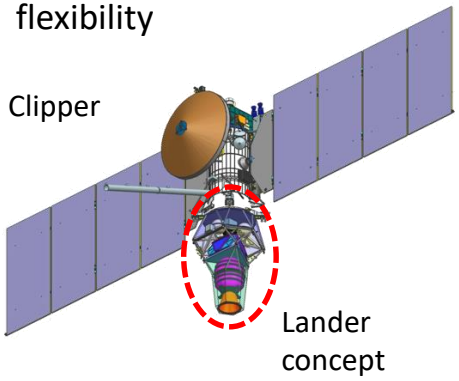


Cruise configuration of standalone concept

Three Lander Architecture Concepts

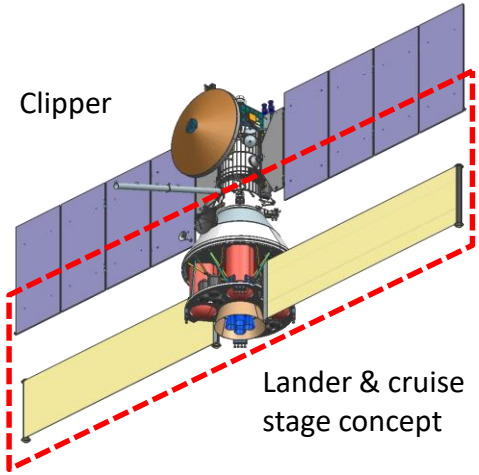
"Piggy Back"

- Minimum combined mass of lander & Clipper
- Significant impact on Clipper: radiation dose, fuel, lifetime
- Significant radiation dose on lander from Clipper mission
- High landing velocity
- Tight coupling between post-landing telecom link availability and lander delivery, no flexibility



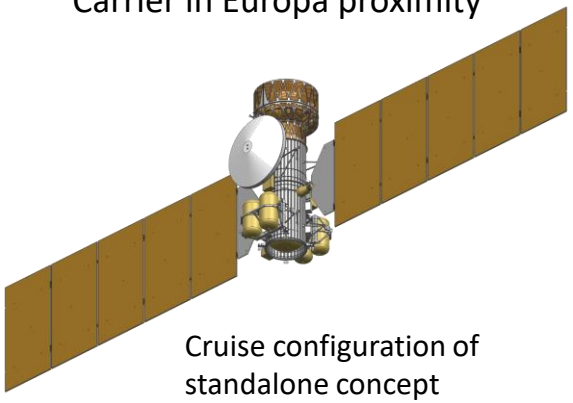
"Free Flyer"

- Higher combined mass of lander & Clipper
- Lower impact on Clipper
- Lander trajectory optimized for minimum radiation dose
- Lower landing velocity
- Clipper relay orbit de-coupled from lander delivery, optimized for post-landing relay coverage



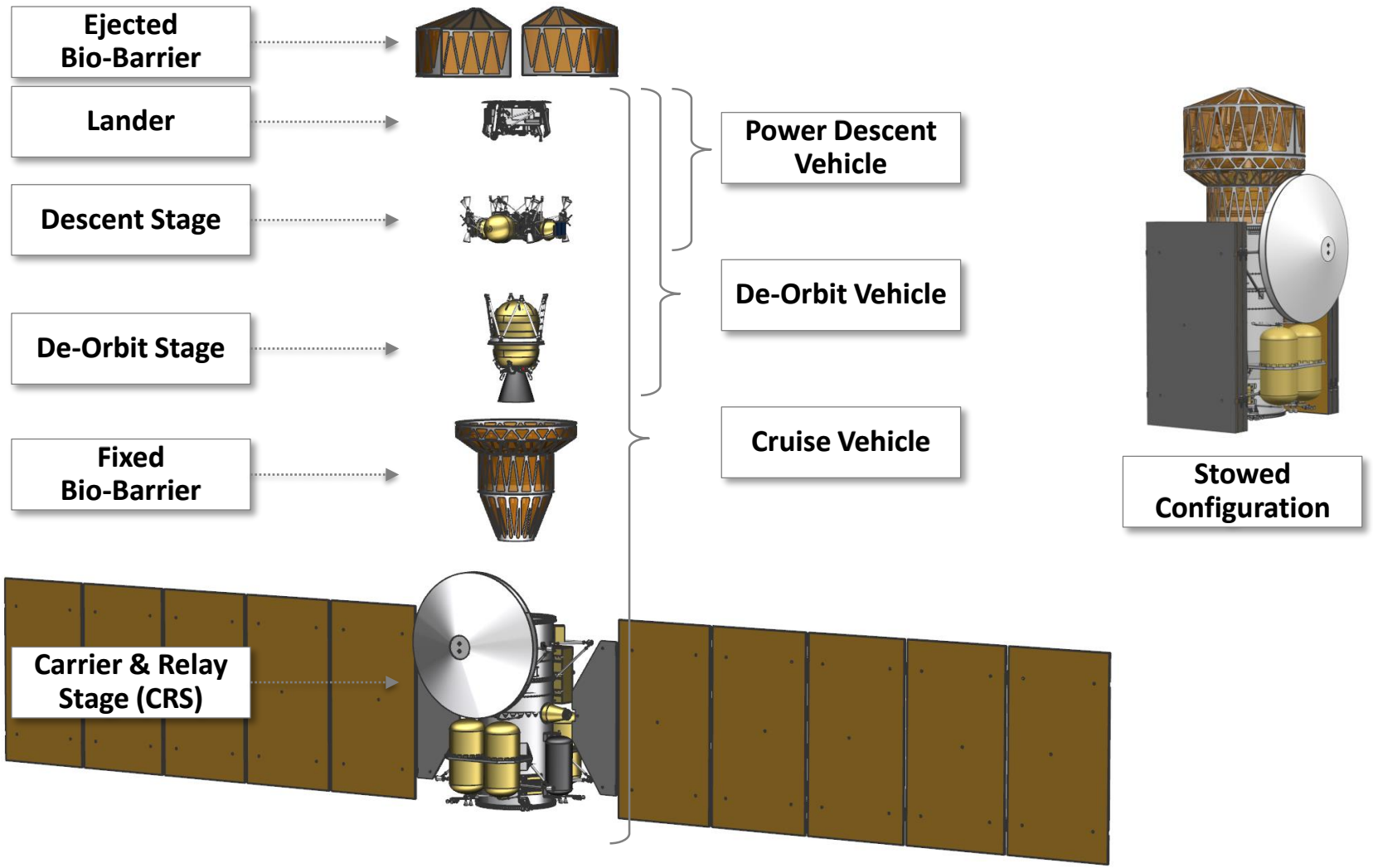
"Standalone"

- Highest combined mass of lander & Clipper
- Minimum impact on Clipper, de-coupled except for recon & backup relay
- Lander trajectory optimized for minimum radiation dose
- Lower landing velocity
- Best relay link availability, Carrier in Europa proximity

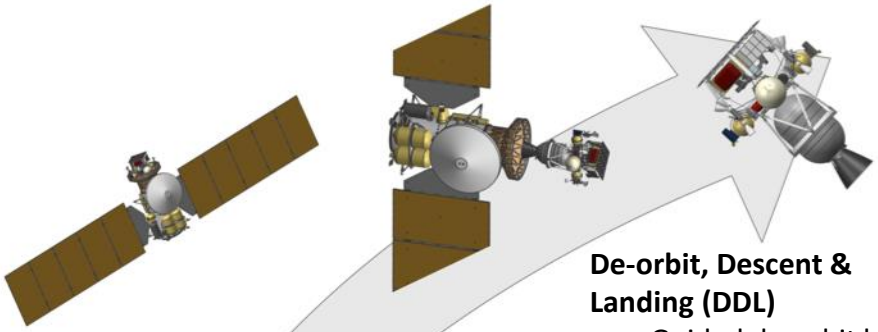


Cruise configuration of standalone concept

Europa Lander Flight System Concept

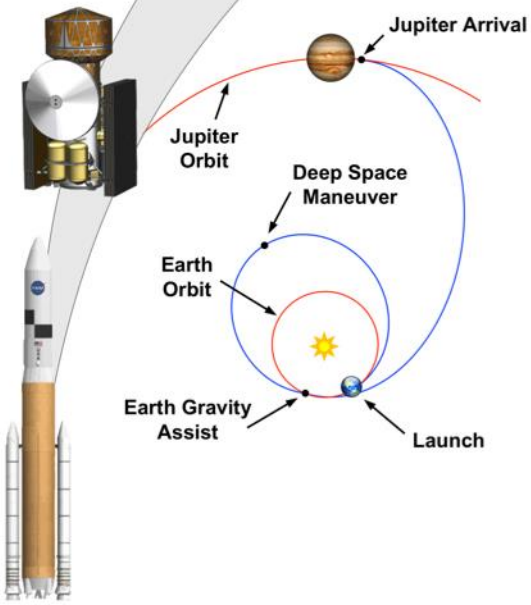


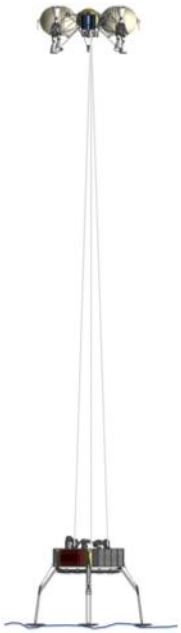
Europa Lander Mission Concept



Cruise & Jovian Tour
- Earth gravity assist: 2027
- Jupiter Orbit Insertion: 2030
- Earliest landing on Europa: 2032

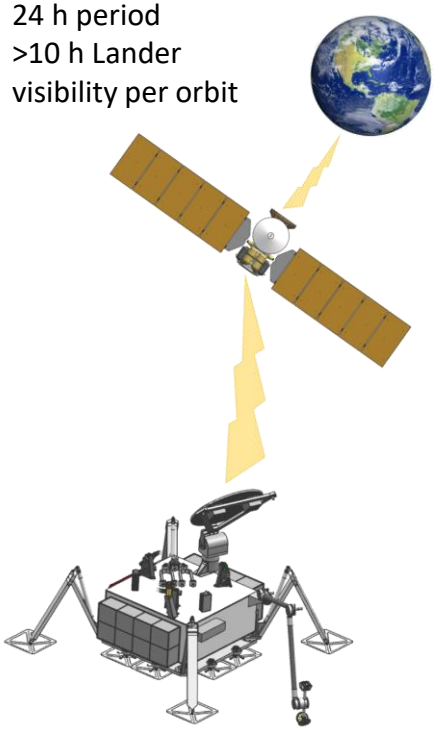
De-orbit, Descent & Landing (DDL)
- Guided de-orbit burn
- Propulsive landing
- 100 m accuracy





Launch
- SLS Block 1b
- 2025

Carrier Relay Orbit
- 24 h period
- >10 h Lander visibility per orbit



Surface Mission
- 20+ days surface mission
- 5 samples
- Relay communications through Carrier or Clipper (backup)
- 3-4 Gbit data return
- 45 kWh battery